Progress to December 2002
Clarity Model, Stream Particles, In-lake Particles

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Project Components

➢ Tahoe Clarity Model

Continued Model Development
Data compilation
Model Validation
Synthetic data set
Long term management scenarios
TMDL

➢ Aggregation (in lake)

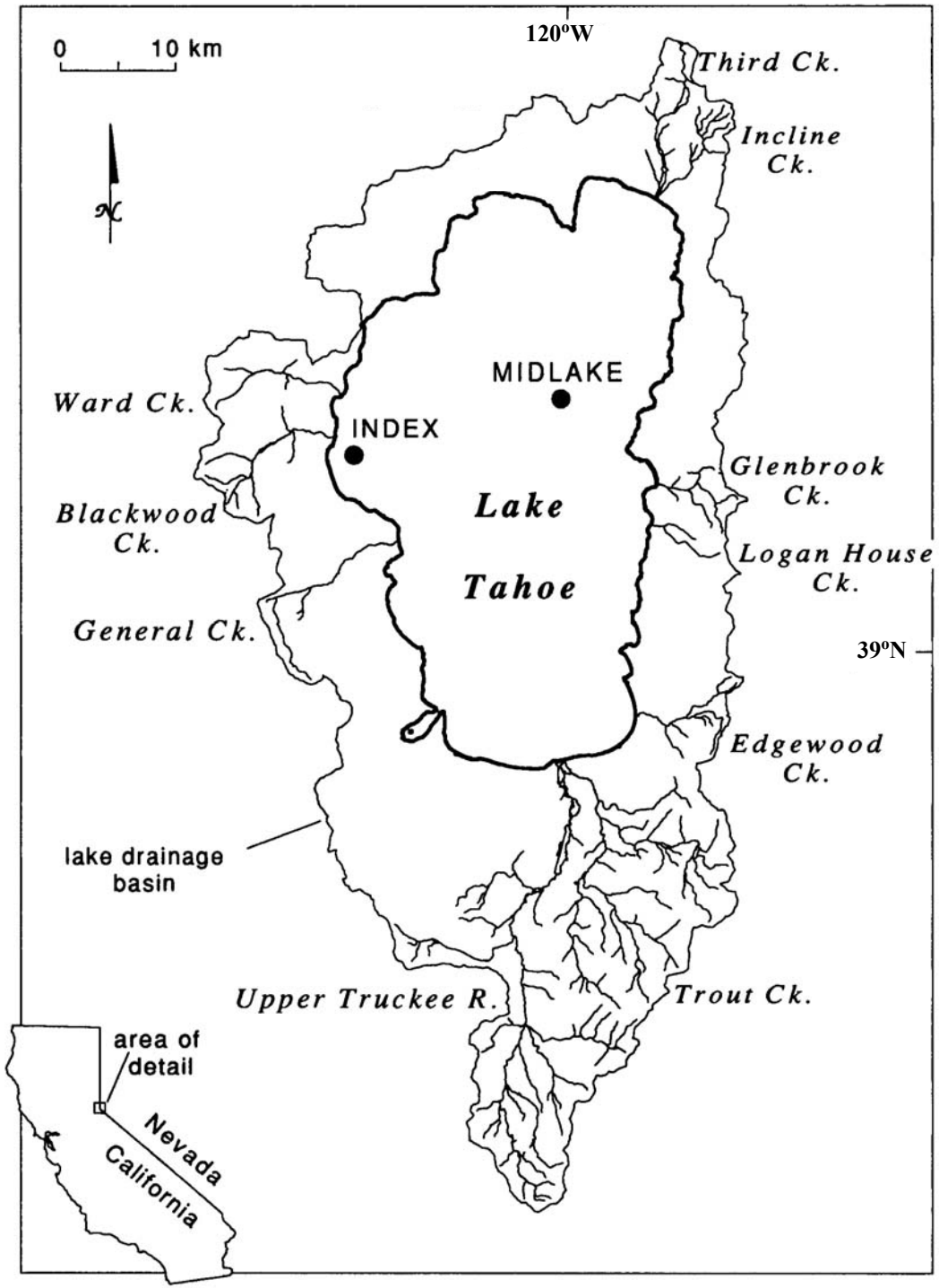
Characterization of lake constituents
- Epifluorescence microscopy
- Confocal laser scanning microscopy
- Flow cytometry
- PSD
- ICP-MS
- Sediment traps and biofilm plates

➢ Streams

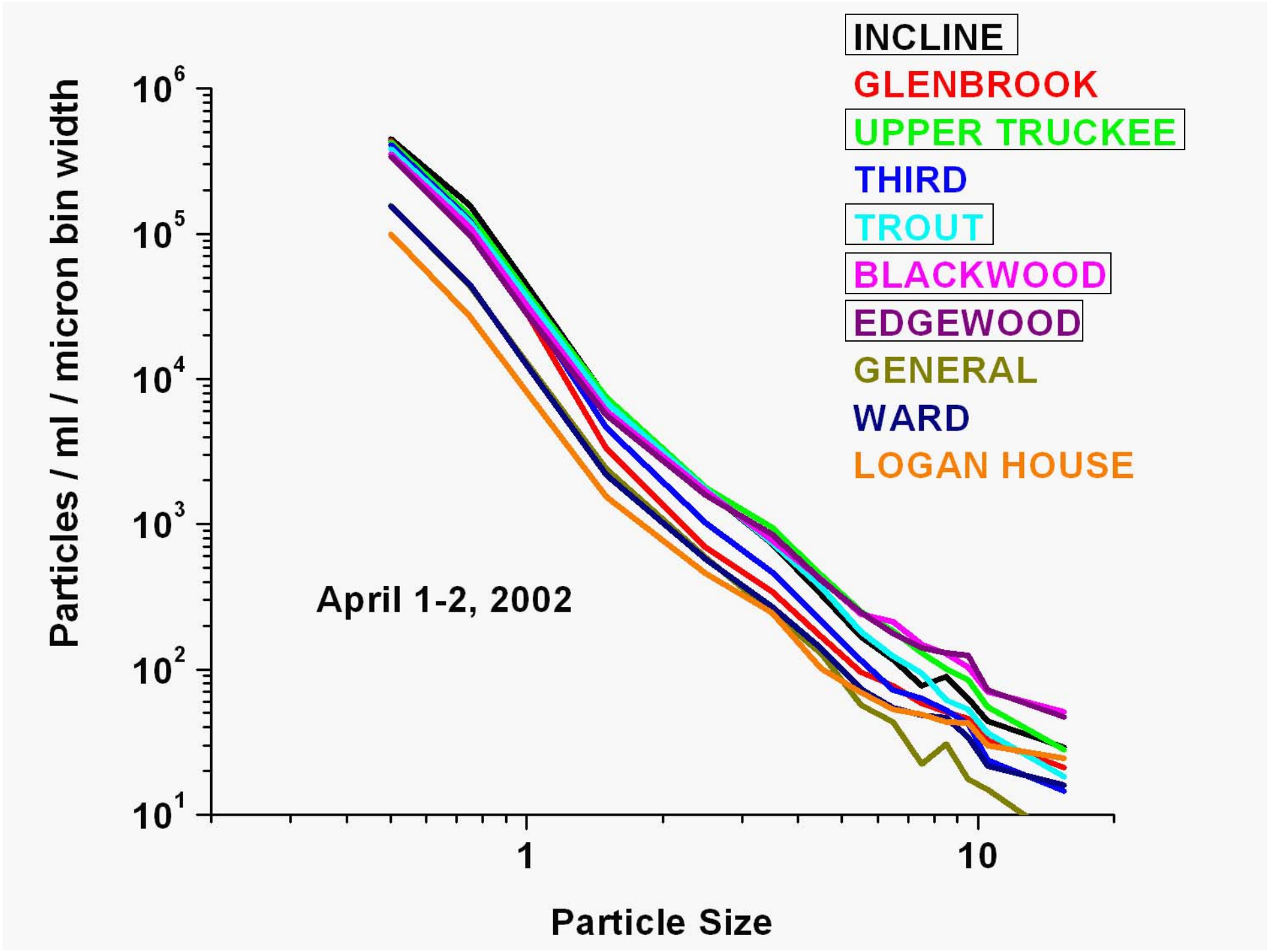
Characterization of stream constituents
- PSD
- ICP-MS

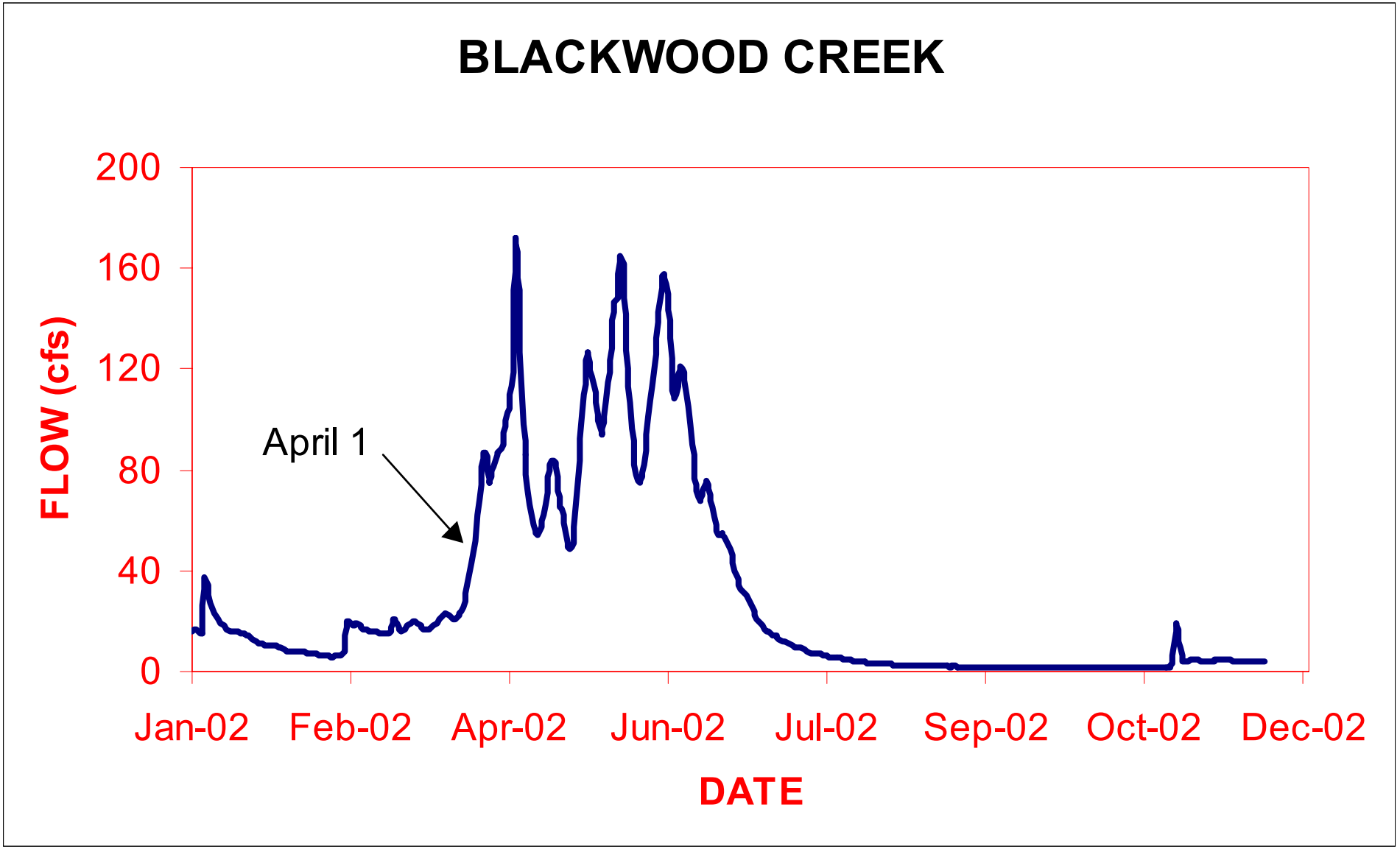
➢ Related Research

CARB	Air Sample ICP-MS
USGS	Groundwater PSD and ICP-MS
	Other lakes PSD and ICP-MS
NASA	Remote sensing
UCD	Real-time meteorological network
DRI	Near-shore turbidity



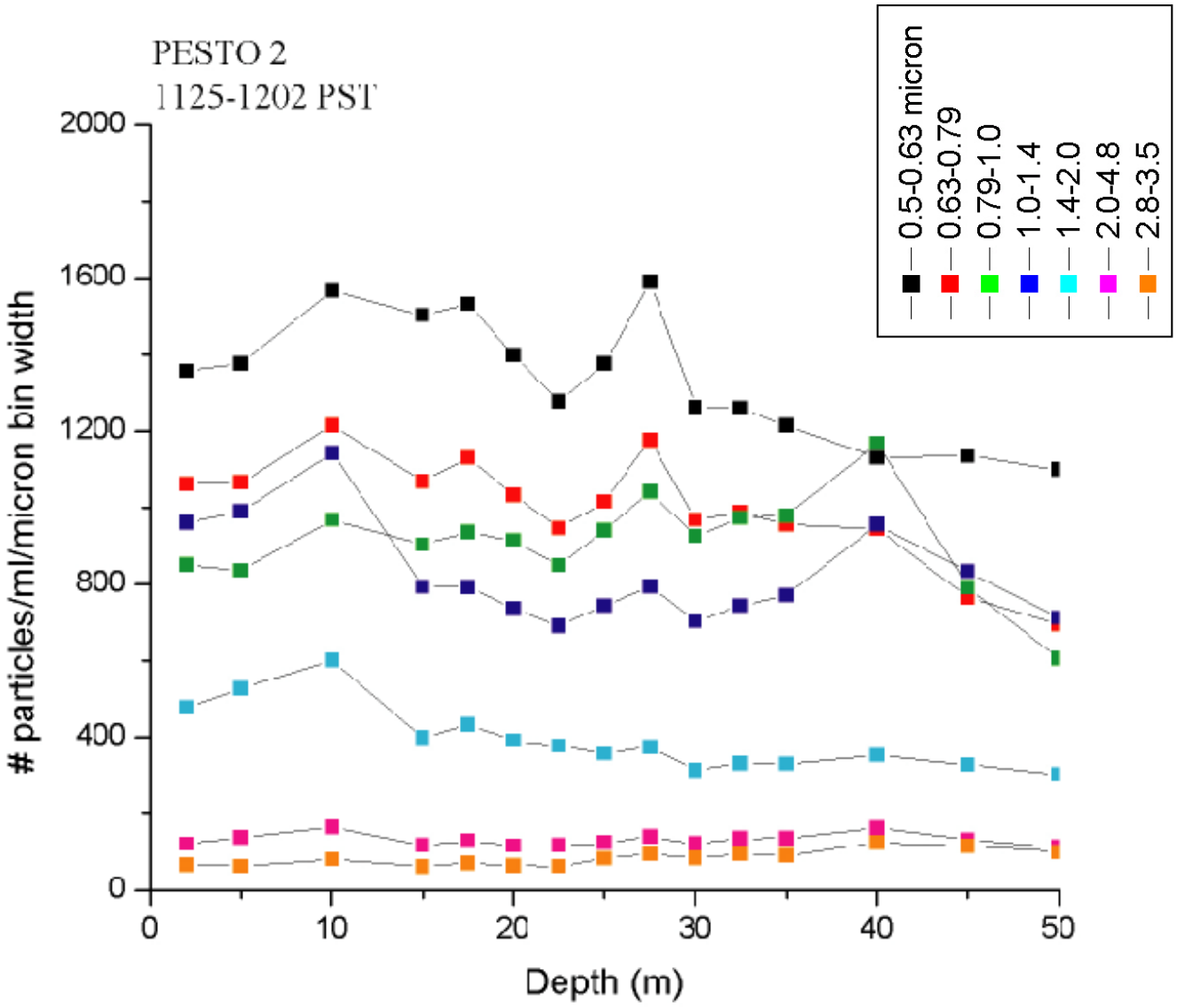
10 LTIMP STREAMS

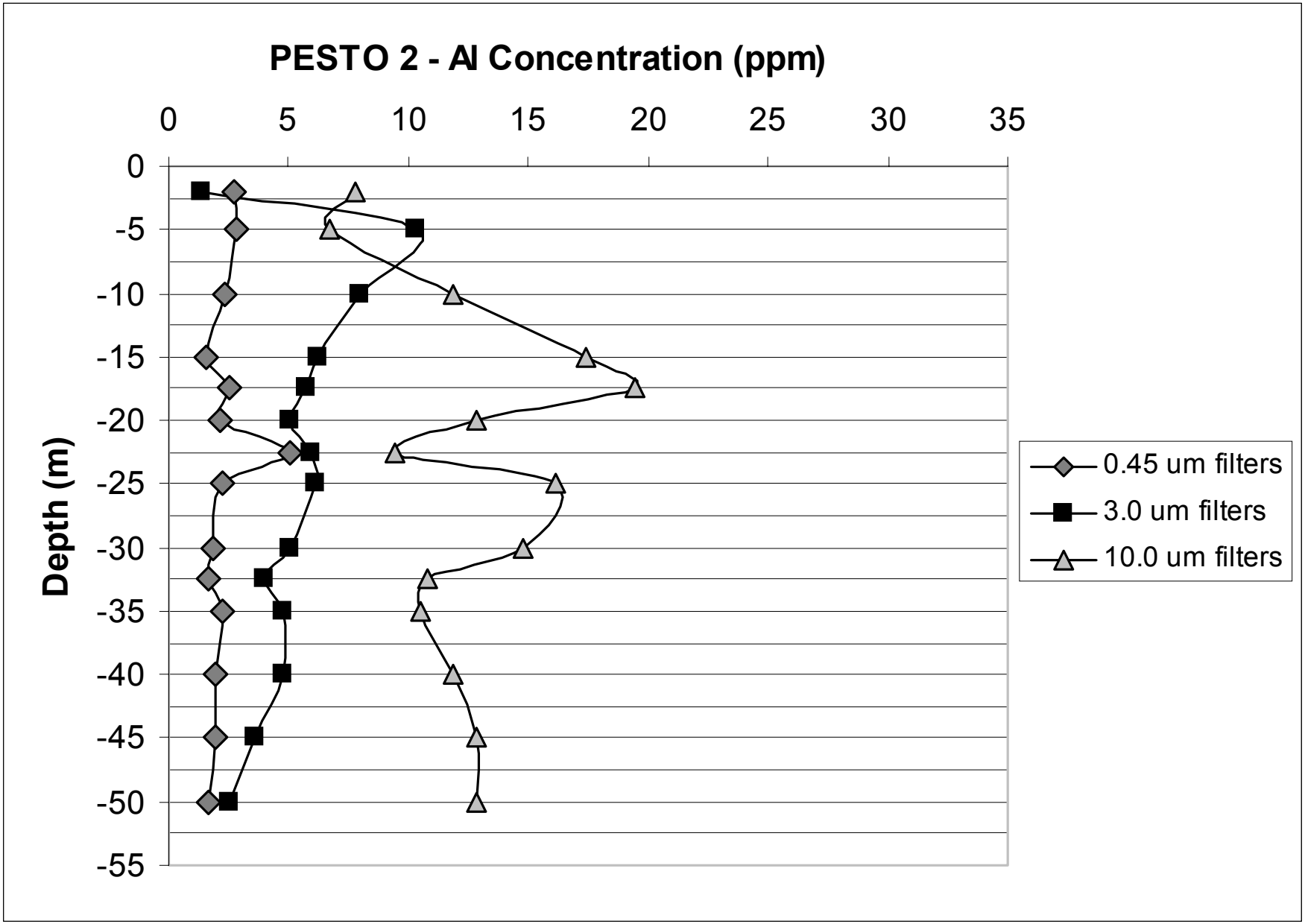

INCLINE
GLENBROOK
UPPER TRUCKEE
THIRD
TROUT
BLACKWOOD
EDGEWOOD
GENERAL
WARD
LOGAN HOUSE
Particles / ml / micron bin width
10^6
10^5
10^4
10^3
10^2
10^1
1
10
Particle Size
April 1-2, 2002


BLACKWOOD CREEK
200
160
120
80
40
0
FLOW (cfs)
April 1
Jan-02
Feb-02
Apr-02
Jun-02
Jul-02
Sep-02
Oct-02
Dec-02
DATE

Questions

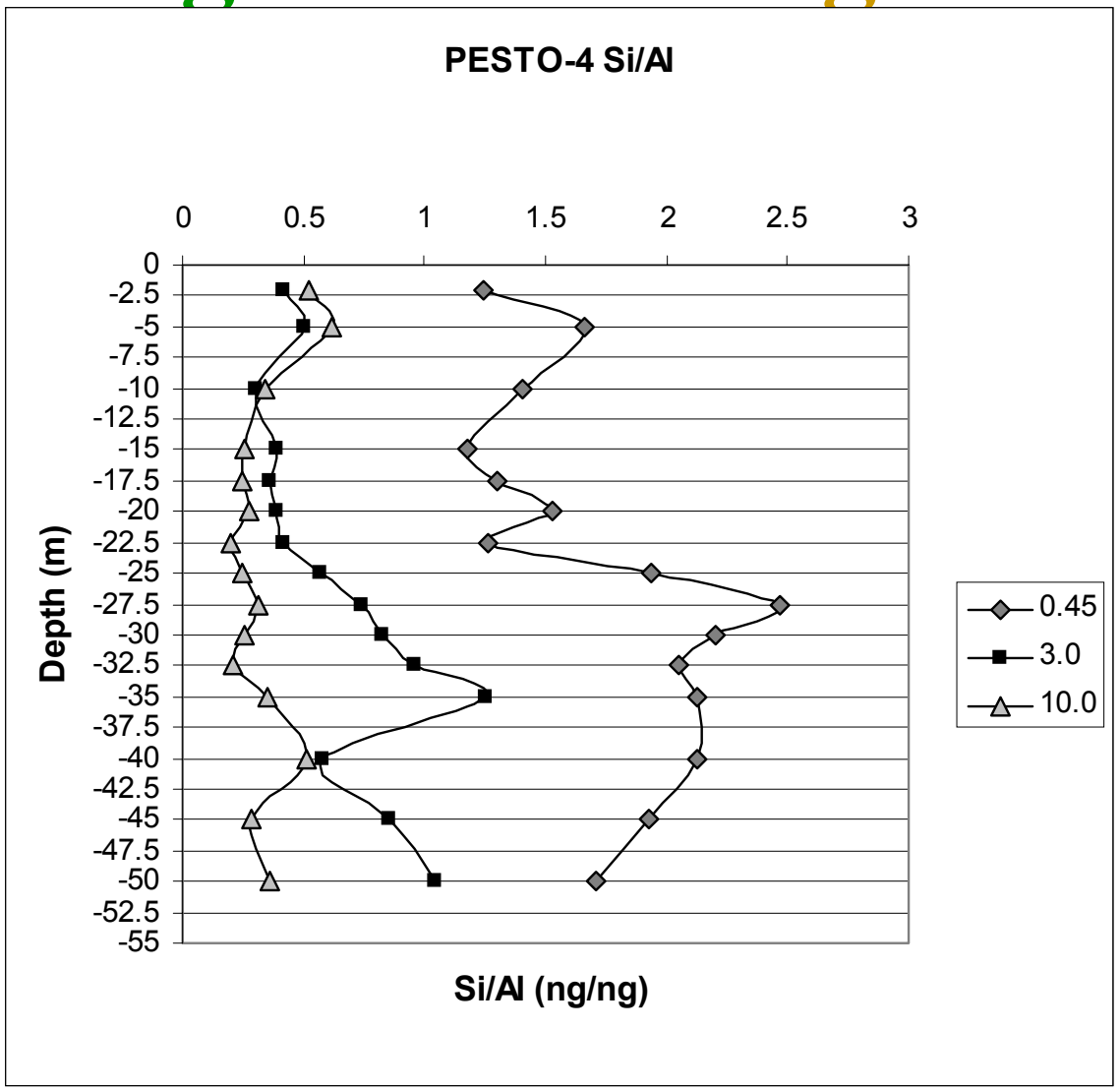
- Nature of particles – organic vs inorganic?
  - Particle sizing and enumeration, serial filtration, ICPMS, flow cytometry
- Source of particles?
  - Streams, near shore turbid zones, air deposition
- Removal mechanisms – role of bacteria in aggregation?
  - Analyze biological material in suspended lake aggregates
    Grow biofilms in the lake and check their composition
    Collect aggregates in sediment traps and study them noninvasively
- Transparency dynamics in water column?
  - In-lake observation


PESTO 2
1125-1202 PST
0.5-0.63 micron
0.63-0.79
0.79-1.0
1.0-1.4
1.4-2.0
2.0-4.8
2.8-3.5
particles/ml/micron bin width
2000
1600
1200
800
400
0
0
10
20
30
40
50
Depth (m)


PESTO 2 - Al Concentration (ppm)
0
5
10
15
20
25
30
35
Depth (m)
0
-5
-10
-15
-20
-25
-30
-35
-40
-45
-50
-55
0.45 um filters
3.0 um filters
10.0 um filters

Nature of Particles

Organic vs Inorganic



Lake Tahoe Clarity Model

DLM-WQ Components

Physical Sub-Model:

- Thermodynamics.
- Mixing Layer Dynamics.
- Hypolimnetic Processes.
- Inflows & Outflows.
- Ground Water.

Water Quality Sub-Model:

- Phytoplankton.
- Nutrients.
- Inorganic Particles.
- Oxygen.
- Atmospheric Deposition.
- Zooplankton & Mysis.

Optical Sub-Model:

- Absorption.
- Scattering.
- Link to Secchi Depth.

Input Data (WQ & Physical):

- Meteorological.
- Inflow (Rate & WQ).
- Initial Conditions.
- Physical Parameters.

Model Assumptions:

- Forcing Parameters.
- 1-D Assumption.

DLM-WQ Linkages

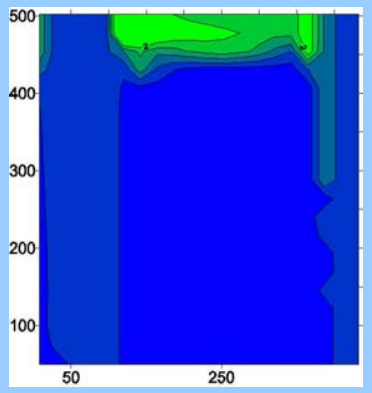
PHYSICAL FORCING INPUTS
MET [U, SW, LW, RH, T , PRECIP]
STREAMS [Q, T]
GROUNDWATER [Q]

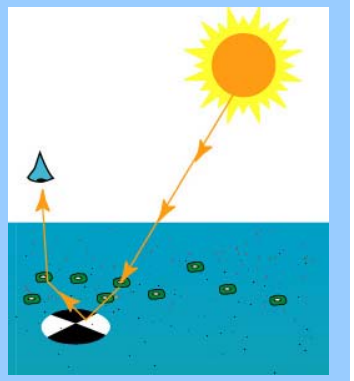
WATER QUALITY INPUTS
STREAMS [DO, BOD, CHL*a*, **P** (PP, THP, POP, RP), **N** (NO3, NH4, DON, PN, PON), # PART]
G/WATER [**P** (THP, RP), **N** (NO3, NH4, DON), # PART]
ATMOS [**P** (THP, POP, RP), **N** (NO3, NH4, DON)]

LAKE CLARITY MODEL

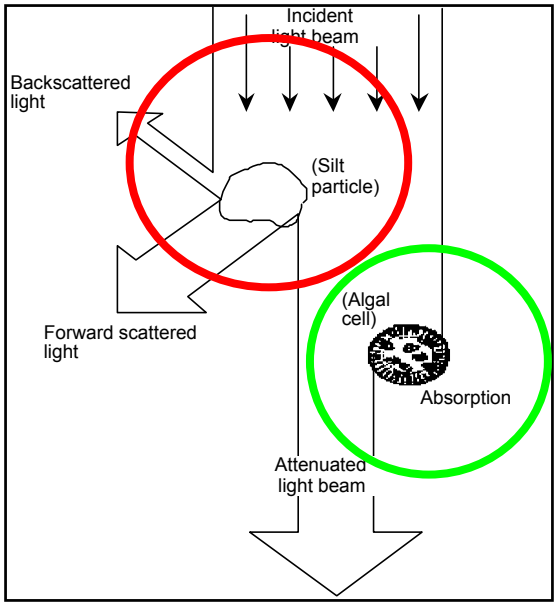
BIOLOGY **PHYSICS**

Vertical distribution of the State Variables as a function of time





Optical Sub-Model Definition



- Scattering by organic particles
- Scattering by inorganic particles
- Scattering by pure water

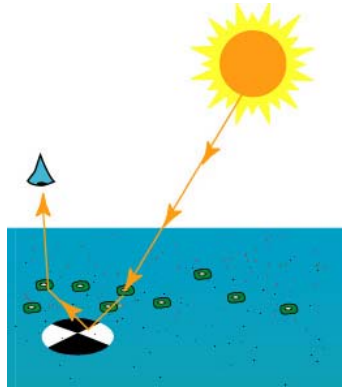
→ **Scattering**

- Absorption by pure water
- Absorption by CDOM
- Absorption by organic particles

→ **Absorption**

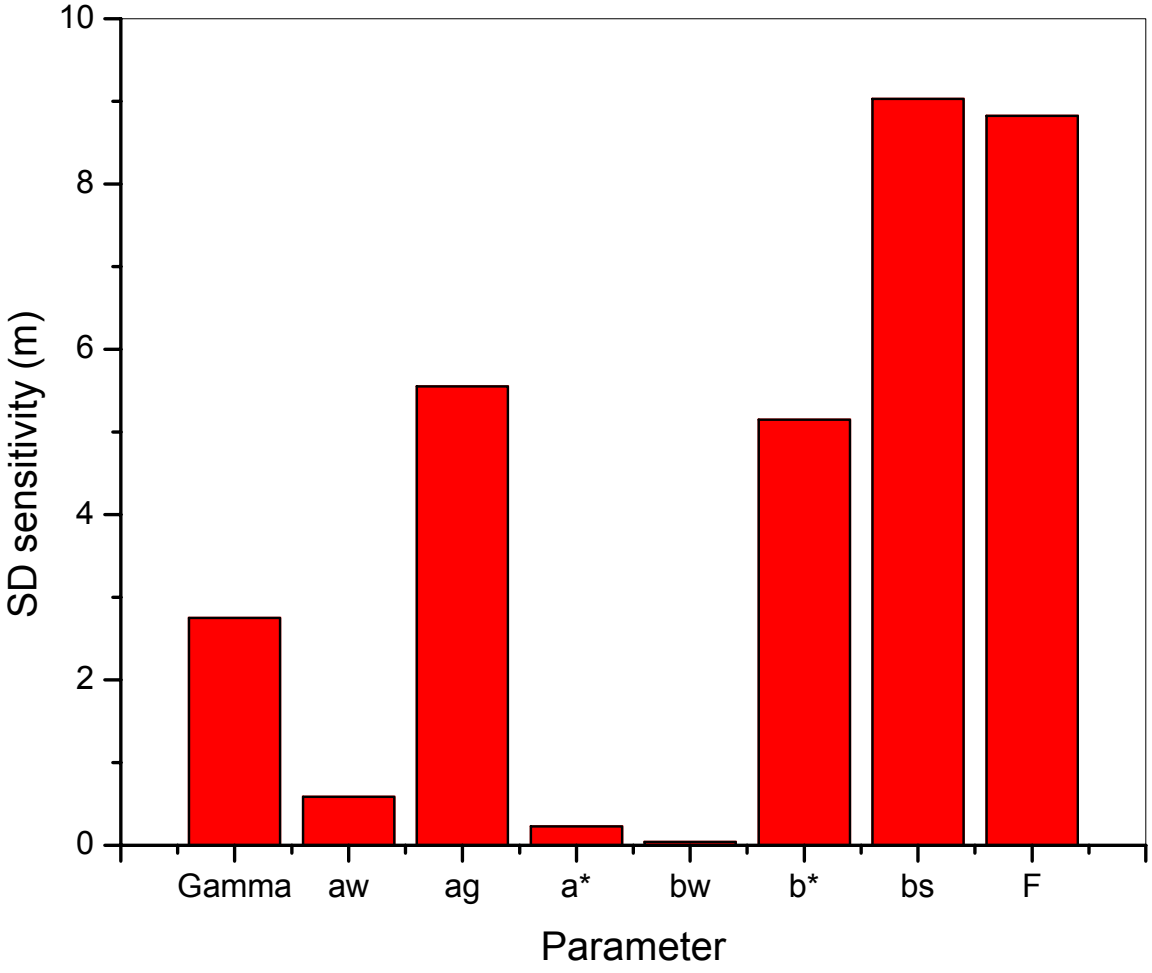
→ **Photopic Response**

$$SecchiDepth = \frac{\gamma}{(c + K_d)}$$



Parameter Sensitivity

1999 - 2001



$$SecchiDepth = \frac{\gamma}{(c + K_d)}$$

$$c = a + b$$

$$a = a_{water} + a_{gelb} + a^*_{Chla} \cdot [Chla]$$

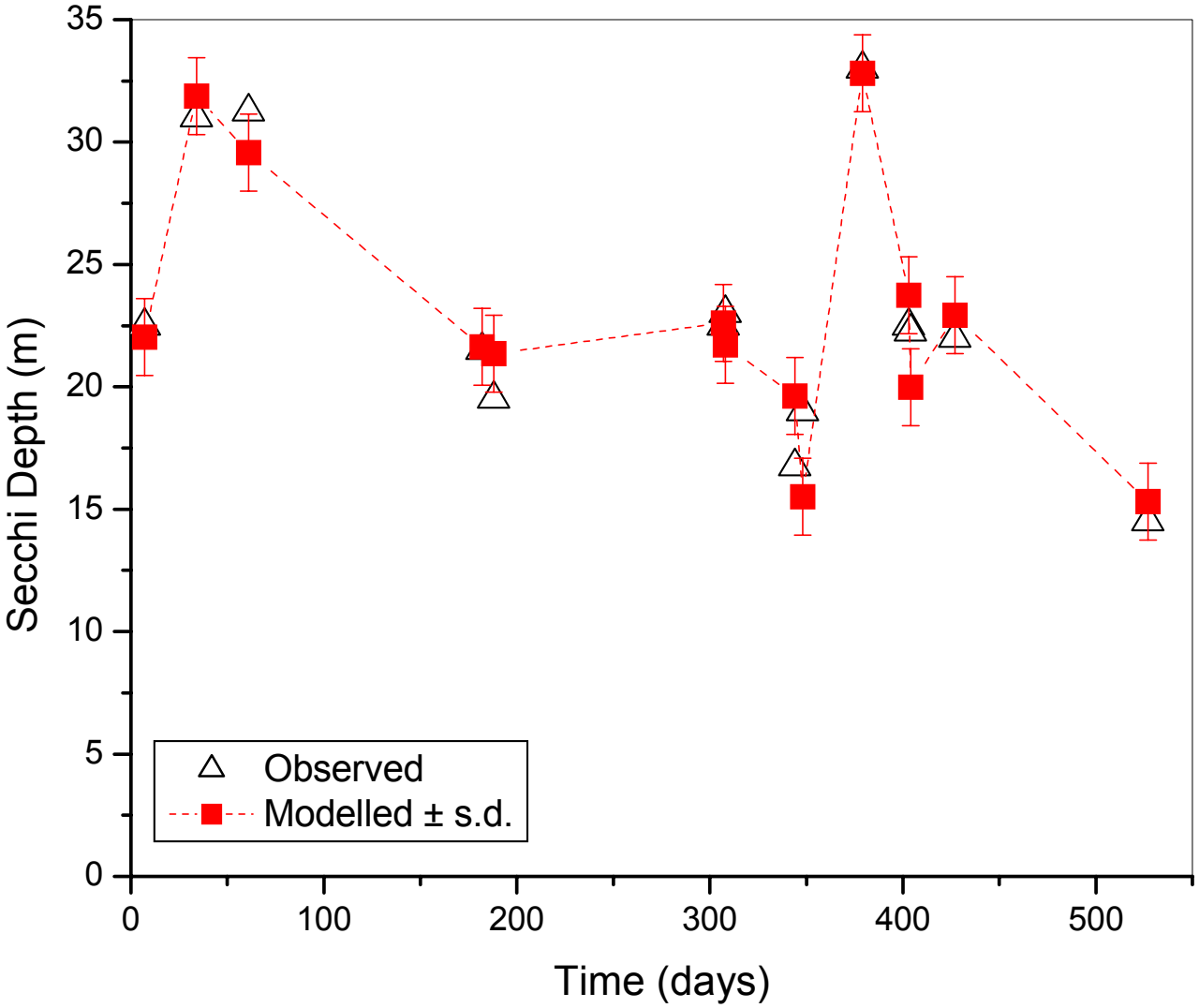
$$b = b_{water} + b_{sed} + b^*_{Chla} \cdot [Chla]$$

Optical Sub-Model Parameters

1. Constant (gamma)
2. Water absorption (aw)
3. Gelbstoffe absorption (ag)
4. Chl-a specific absorption (a*)
5. Water scattering (bw)
6. Chl-a specific scattering (b*)
7. Sediment scattering (bs)
8. Inorganic fraction (F)

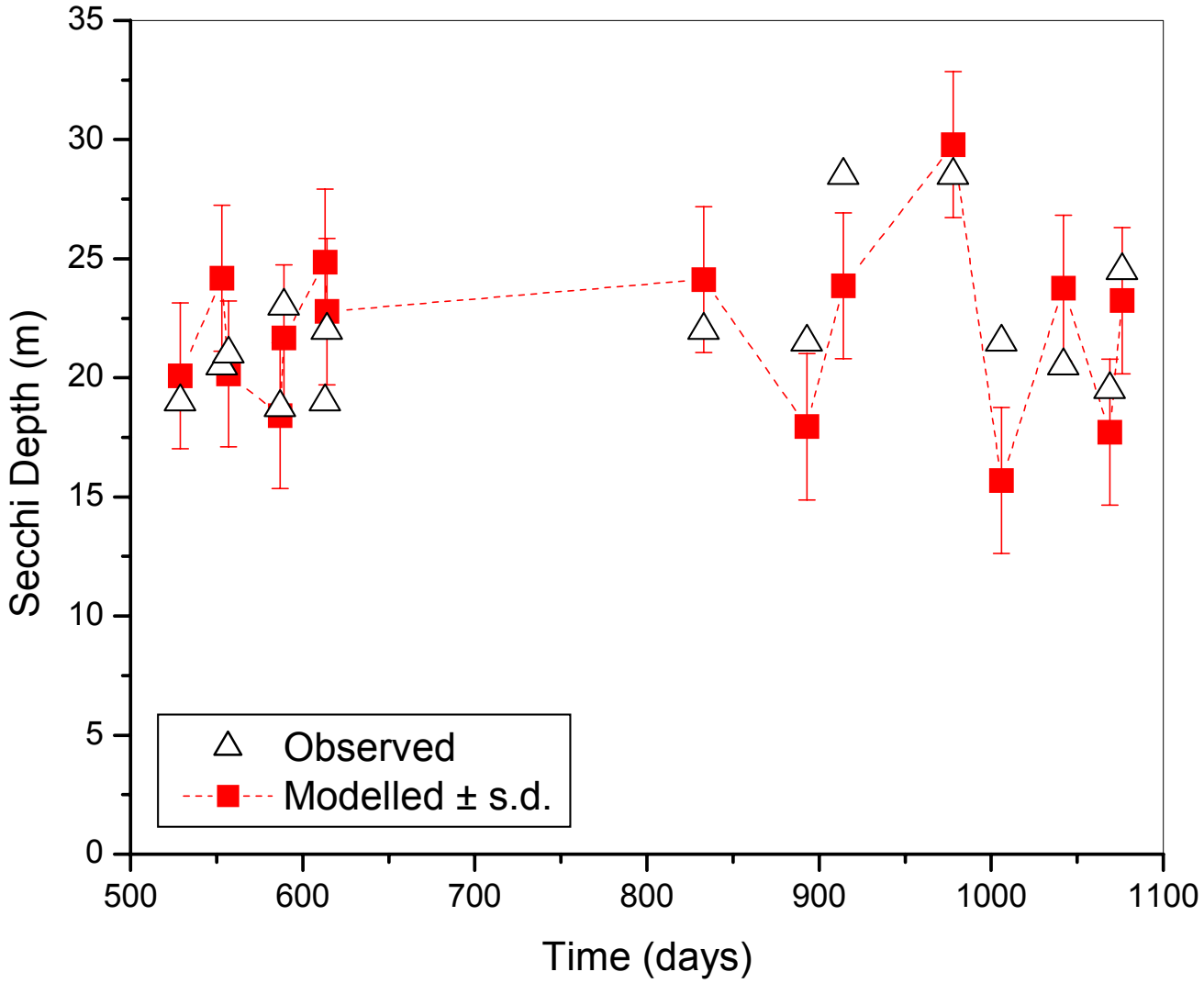
Calibration of Optical Sub-Model

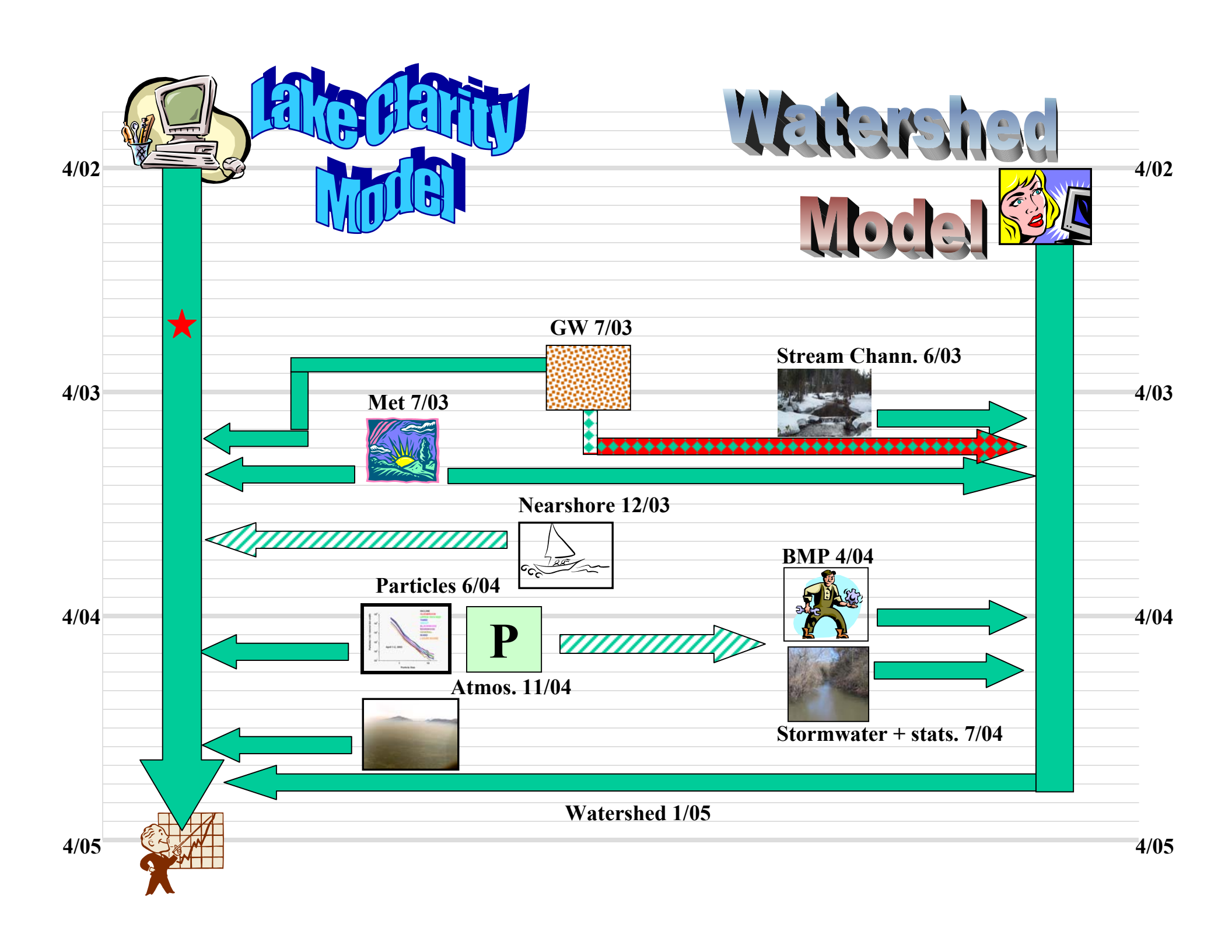
1999 - 2000



Validation of Optical Sub-Model

2000 - 2001




Lake Clarity Model
Watershed Model
4/02
4/03
4/04
4/05
GW 7/03
Stream Chann. 6/03
Met 7/03
Nearshore 12/03
BMP 4/04
Particles 6/04
P
Atmos. 11/04
Stormwater + stats. 7/04
Watershed 1/05

Things we need to help make Dave happy

- "Preliminary inputs" long before final reports
- Met data
  - Validation:reconstructed + hydrology to match lake level
  - Future scenarios – next 50 years may not be like the last 50 years?
- Groundwater – demarcation between direct lake input and stream input. Intervening zones?
- Nearshore Turbidity Zone – are these stagnant hot spots? If not, what is flux?
- Stream particles, nutrients – if important, plunge depth of streams?
- Aggregation
- Nutrients – linkages between BAP and SRP/TP. Particle/BAP? – maybe atmospheric particles too?
- Atmospheric – particle loads, P-loads. Do controlled burns have an effect? Effect of a hot burn?
- Channel erosion
  - PSD and ICP-MS of erodable material
  - Linkage between Q, TSS, PSD
  - How factored in hydrology output
- Stormwater runoff
  - ICP-MS analysis
  - Intervening zones? Or hydrological model output
  - Bob Coates methodology for P, N and particles (for calibration, validation)
- BMP effectiveness early